Bonding sep 19
Monday, September 19, 2022 6:08 PM

Chemical Bonding

Chemical Bond → Attractive force b/w two atom which binds them together.

㊉ When Bond forms, Energy is Released.
㊉ More is Energy Released, More strong Bond is formed.

ON the BASIS OF E_R, Bonds are Classified as

① Weak Bond → Vander Waal Bond $\boxed{|E_R| \leq 8\ kJ/mole}$
└→ Hydrogen Bond $\boxed{8 < |E_R| \leq 43\ kJ/mole}$

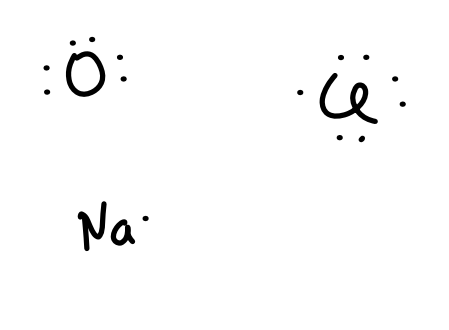
② Moderate and Strong Bond → Metallic Bond, Co-ordinate Bond, Covalent Bond, Ionic Bond → $|E_R| > 43\ kJ/mole$

Note:- 1) According to Lewis, Atom Participate in Bond formation to achieve Noble Gas outershell Configuration ($8e^-$ or $2e^-$)
$8e^-$ ⇒ Octet → 4 orbitals of Valence shell are filled → $\boxed{s + p_x + p_y + p_z}$
$2e^-$ ⇒ Duplet (for Hydrogen) → 1s orbital is filled

2) Lewis Dot Symbol

(Symbol) V.S.e as Dot

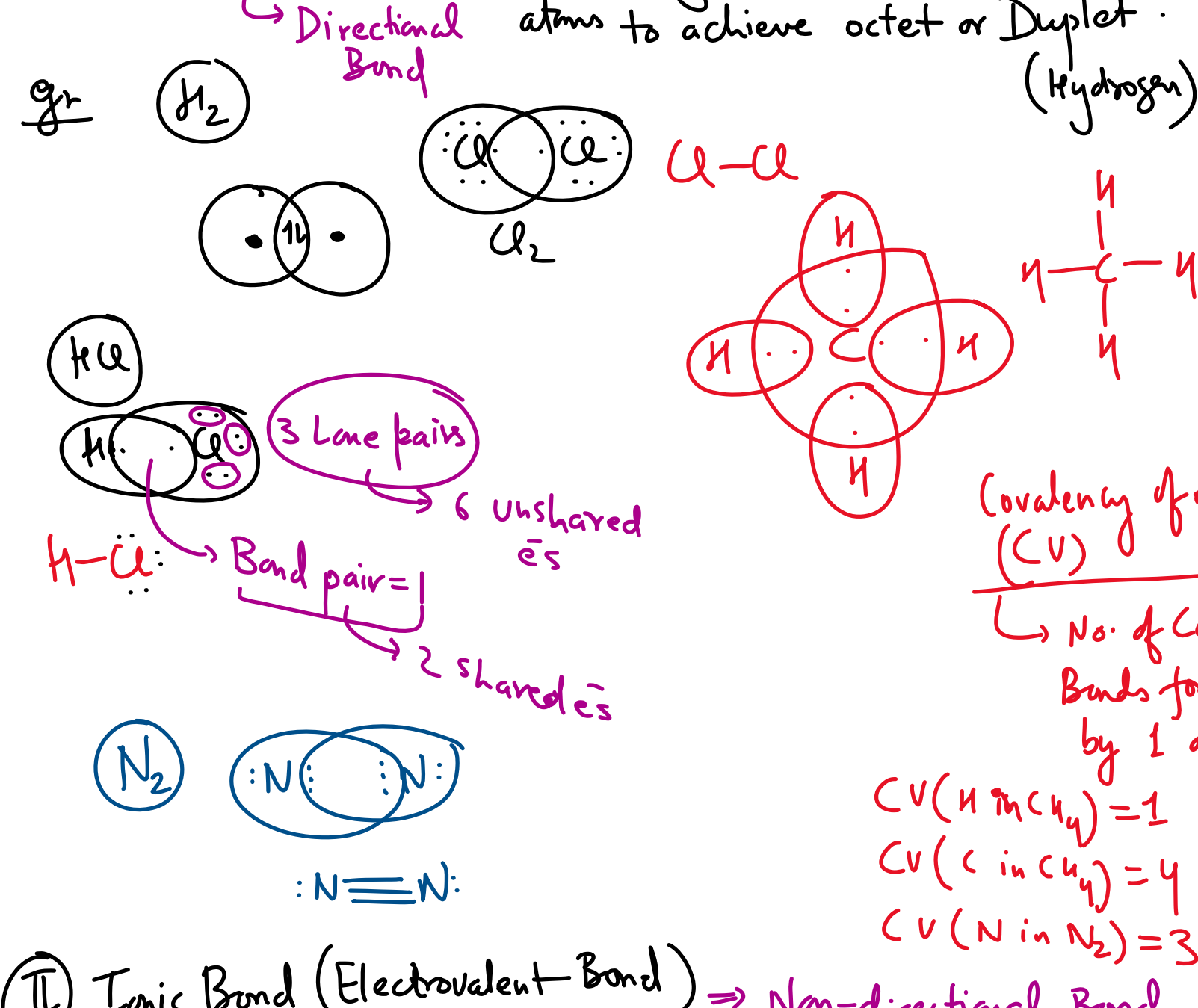
Li, Na, K, Rb, Cs → V.S.e = 1
Be, Mg, Ca, Sr, Ba → V.S.e = 2
B, Al, Ga → V.S.e = 3
C, Si, Ge → V.S.e = 4
N, P, As, Sb → V.S.e = 5
F, Cl, Br, I, → V.S.e = 7
Xe → V.S.e = 8
O, S, Se → V.S.e = 6
S → $1s^2 2s^2 2p^6 \boxed{3s^2 3p^4}$ → Valence shell → V.S.e = 6



$Na = 1s^2 2s^2 2p^6 3s^1$ → V.S.e
$Na^+ = 1s^2 2s^2 2p^6$ → V.S.e = 8

Ⓘ Covalent Bond → Mutual sharing of ēs b/w two non-metallic atoms to achieve octet or Duplet (Hydrogen).

└→ Directional Bond

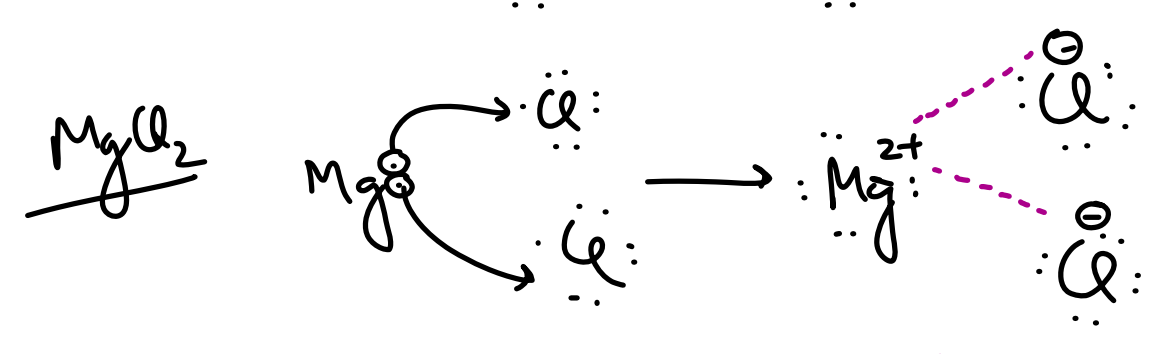


Covalency of atom (CV)
└→ No. of Covalent Bonds formed by 1 atom
CV(H in CH_4) = 1
CV(C in CH_4) = 4
CV(N in N_2) = 3

Ⓘⓘ Ionic Bond (Electrovalent Bond) ⇒ Non-directional Bond

Due to complete transfer of ēs from metallic atom to Non-metallic atom, Atoms convert into Cation & Anion.

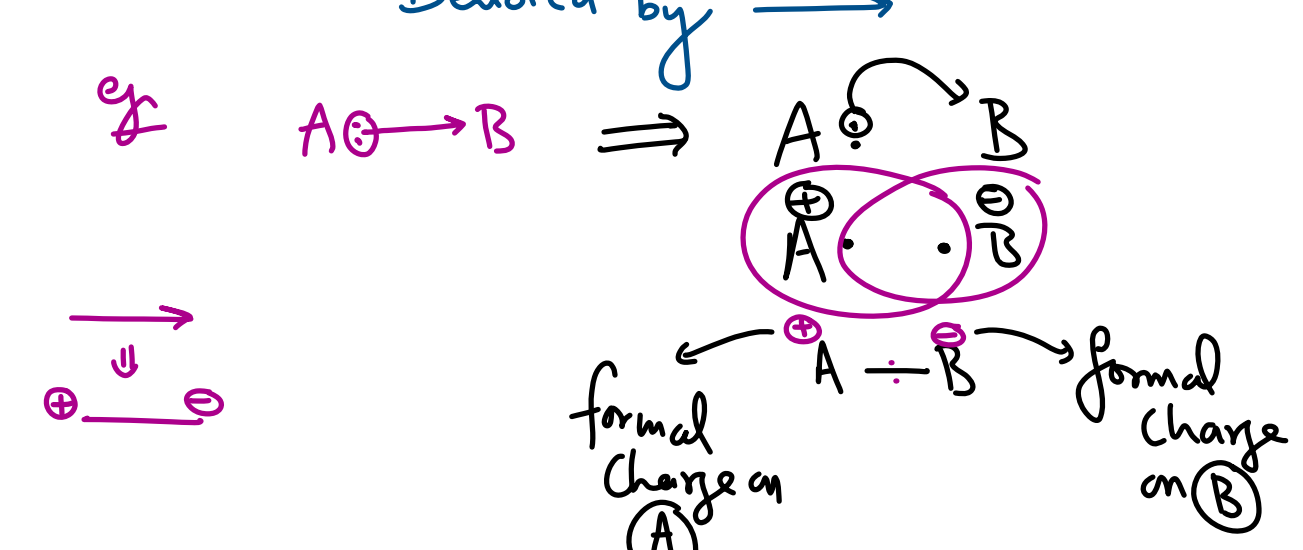
Electrostatic force of attrⁿ b/w Cation & Anion is Ionic Bond.



Electrovalency of Cl in $MgCl_2$ = 1
" " Mg in $MgCl_2$ = 2

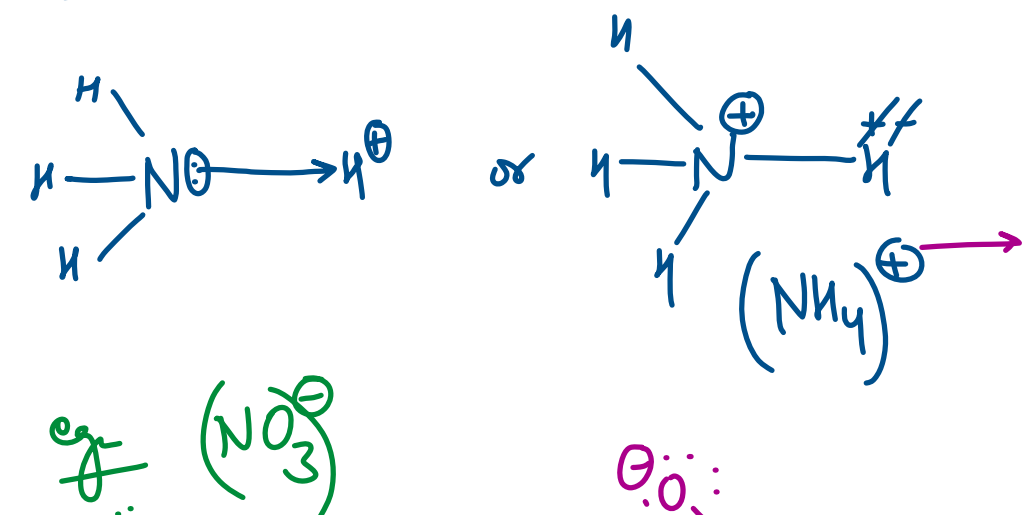
Ⓘⓘⓘ Co-ordinate Bond or DATIVE Bond or Coordinate Covalent Bond

→ Special type of Covalent Bond in which sharing is done only By one atom.
→ Denoted by "→"



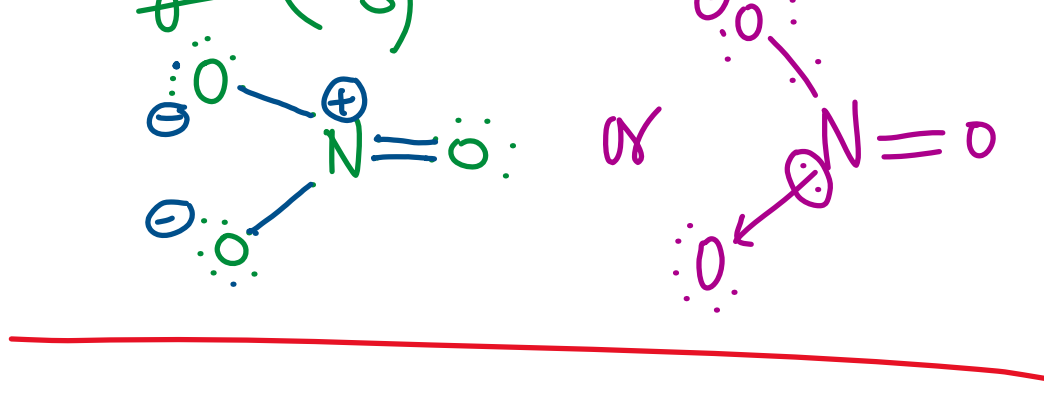
㊉ Formal charge (FC) on any atom is that charge which represent how many ēs are gained or lost during Covalent Bond formation.

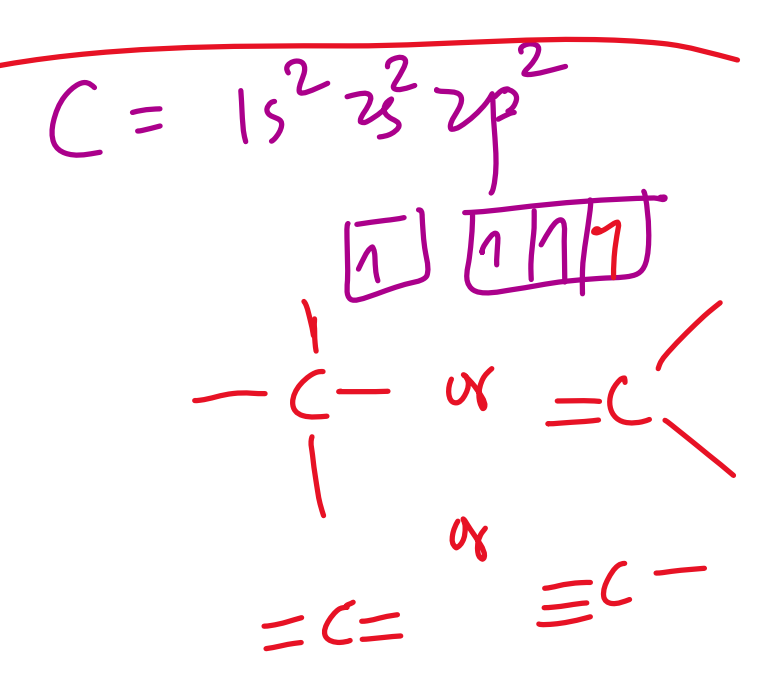
eg:- $NH_3 + H^+$

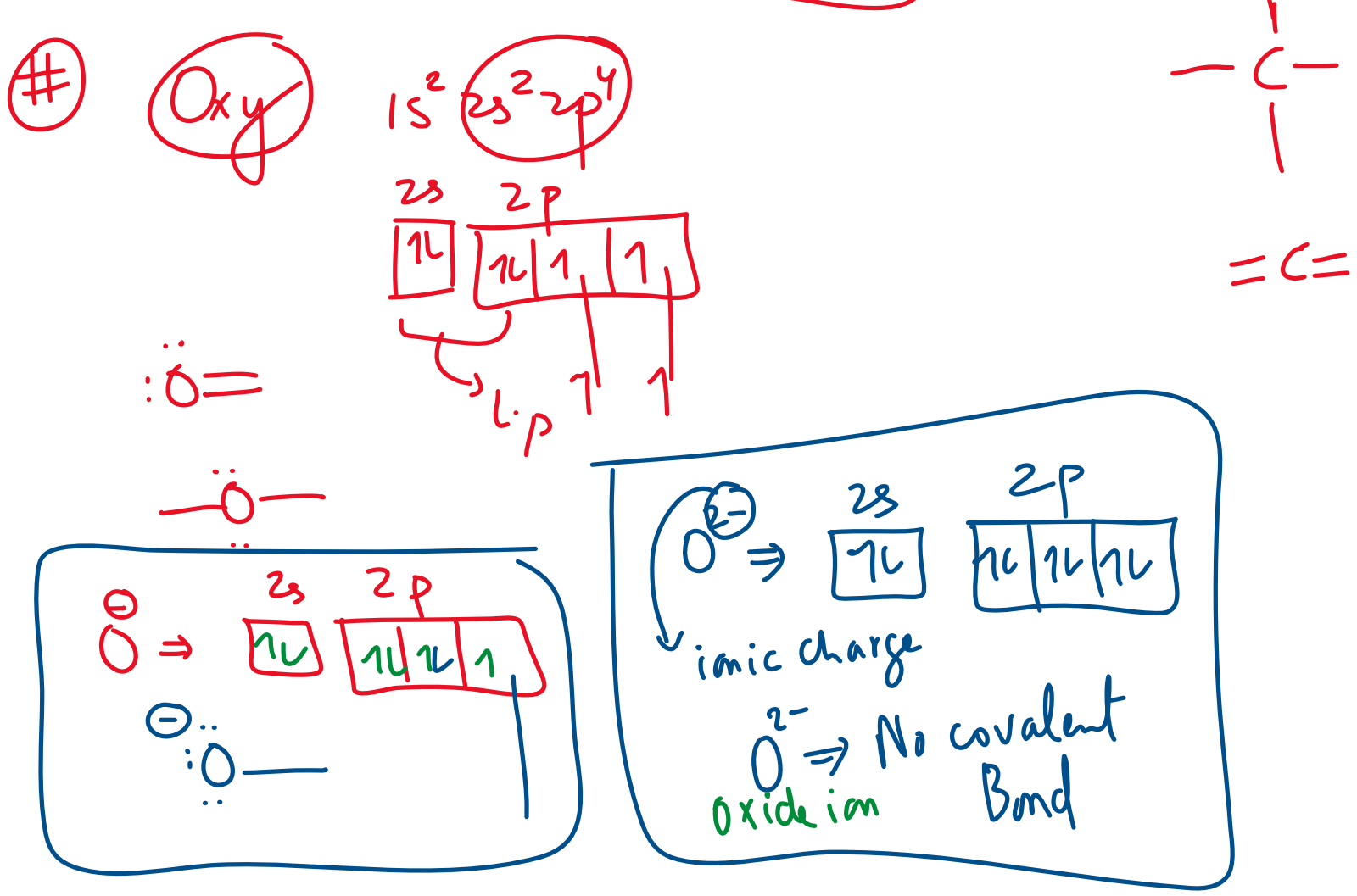


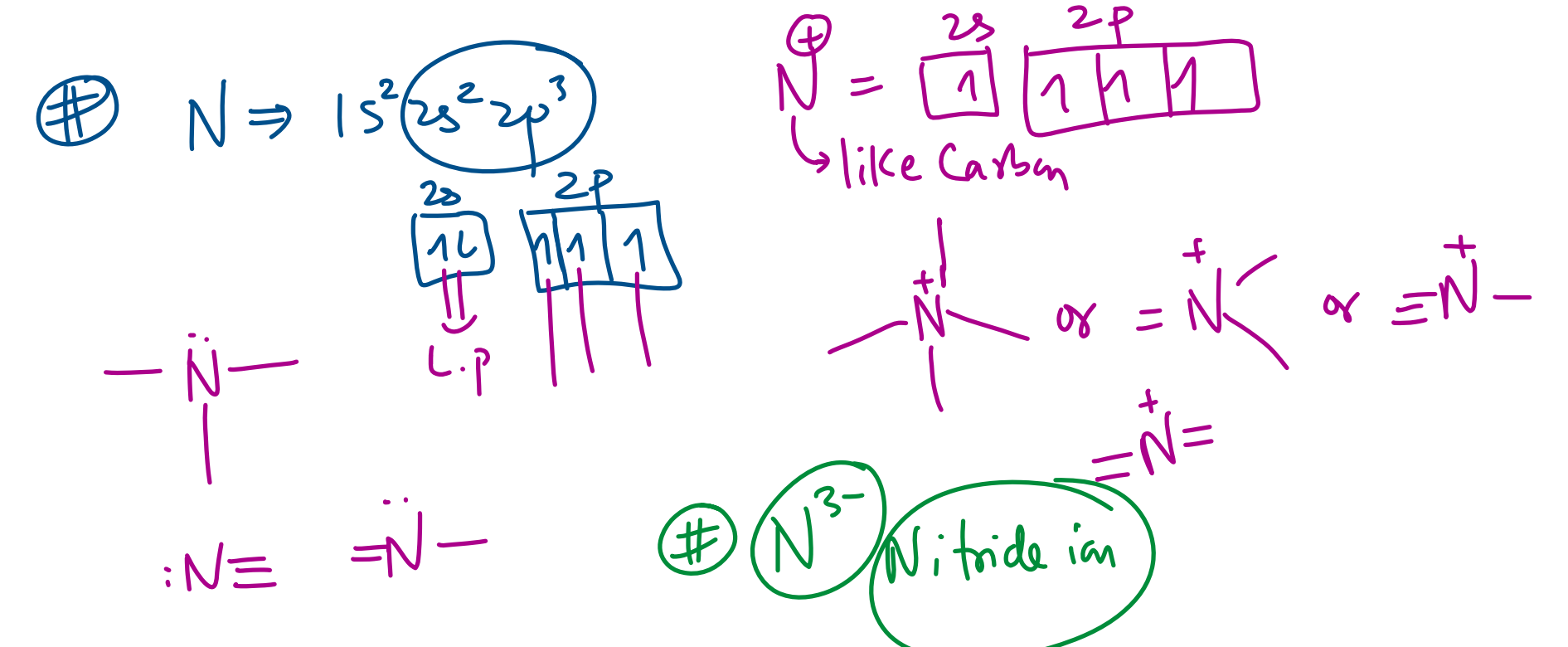
$(NH_4)^+$ → Ionic Charge of Species = Σ formal charge on all atoms

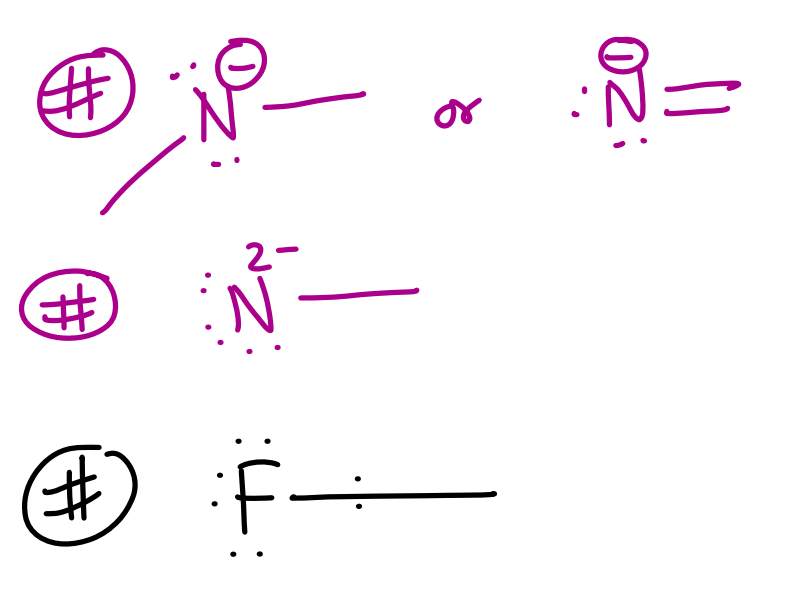
eg (NO_3^-)











Covalent Bond Theories

① Lewis Concept & Lewis Dot Structures (LDS)

└→ Bonds formation only take place by any atom to Complete its octet or Duplet. → Duplet Rule and Octet Rule
octet → set of 4 orbitals ($s + p_x + p_y + p_z$)
Duplet → 1s

Calculation for LDS :—

① n_1 = Sum of valence shell e^- of all atoms − (+ve charge) + (−ve charge)
$\boxed{n_1 \text{ is always even}}$

② n_2 = (No. of H-atoms) × 2 + (No. of other atoms) × 8

③ $n_3 = n_2 - n_1$ = Shared No. of ēs
$\boxed{\text{Bonds} = \frac{n_3}{2}}$

④ $n_4 = n_1 - n_3$ = No. of unshared ēs
Total L.ps = $\frac{n_4}{2}$

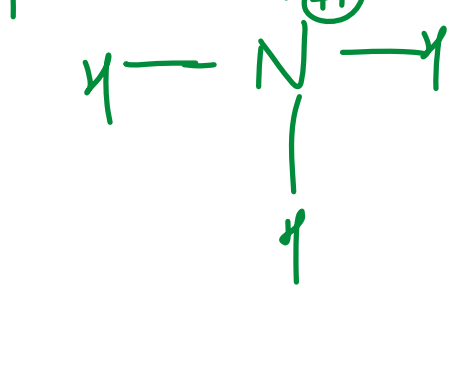
⑤ Identify center atom ⇒ Less in No. or less electronegative or Bigger in Size

⑥ Calculate Formal Charge on every atom

F.C(Atom) = V.S.e − No. of Bonds − No. of unshared ēs

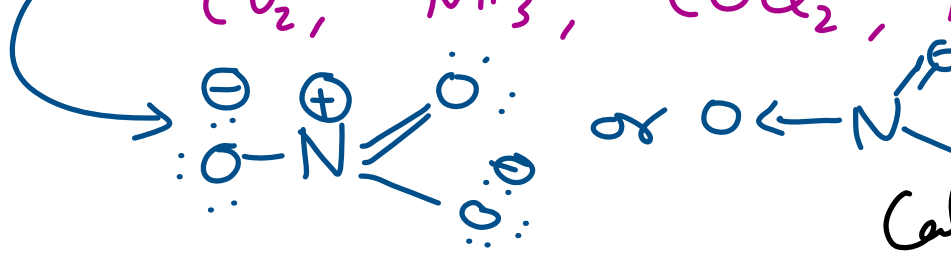
$\boxed{\text{Sum of formal charge of all atoms = Ionic charge of species}}$

egn $(NH_4)^+$
$n_1 = 5 + 4 - 1 = 8$
$n_2 = (4 \times 2) + 8 = 16$
Bonds = $\frac{n_3}{2} = \frac{16-8}{2} = 4$
$n_4 = n_1 - n_3 = 8 - 8 = 0$
L.ps = 0
Center atom ⇒ N

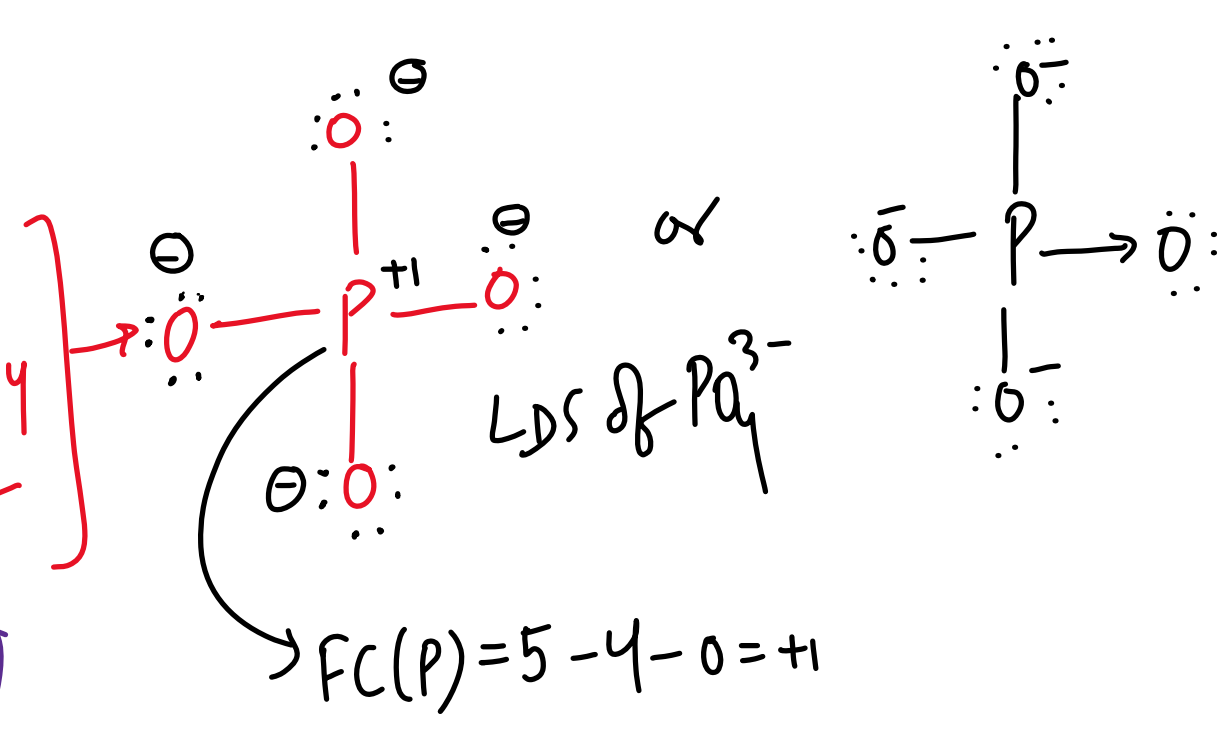


FC(H) = 1 − 1 − 0 = 0
FC(N) = 5 − 4 − 0 = +1

eg CO_3^{2-}, NO_3^-, NO_2^-, NO_2^+, HOCl, SO_4^{2-}, PO_4^{3-}, CO_2, NH_3, $COCl_2$, NO_2F, CO.



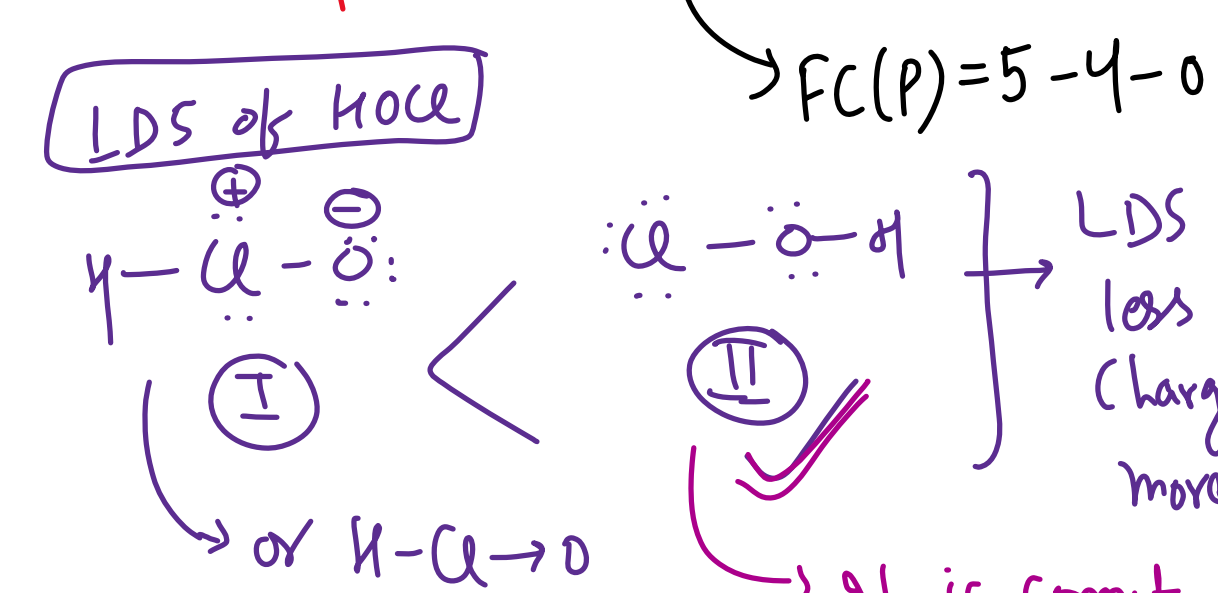
PO_4^{3-} → $n_1 = 32$, $n_2 = 5 \times 8 = 40$, $n_3 = 8$, Bonds = 4, $n_4 = 32 - 8 = 24$, L.ps = 12



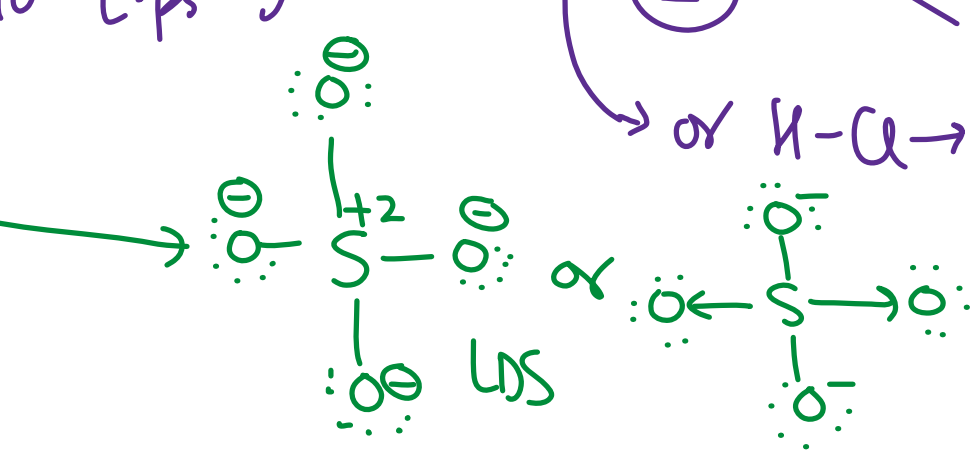
FC(P) = 5 − 4 − 0 = +1

HOCl → $n_1 = 14$
$n_2 = 2 + 16 = 18$
$n_3 = 4$ Bonds = 2
$n_4 = 10$ L.ps = 5

LDS of HOCl



LDS having less formal Charges on atoms is more stable.
Ⓘⓘ → It is Correct LDS of HOCl



Calculation & Octet Rule

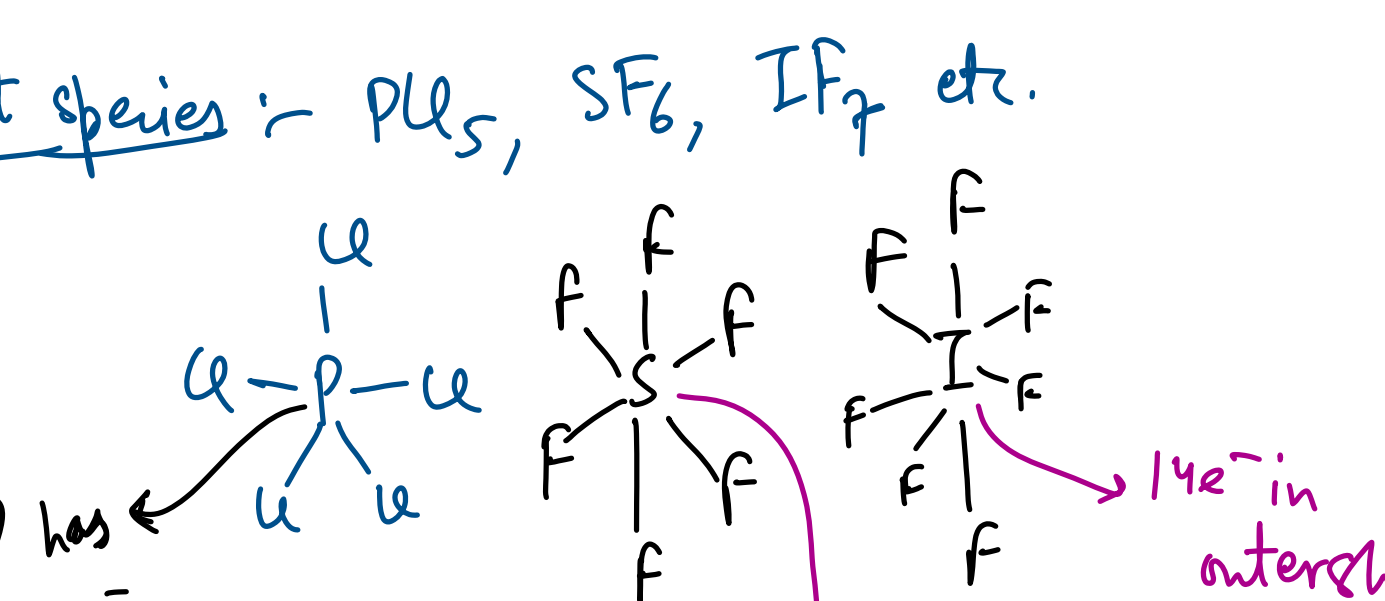
Limitations of Lewis Dot structure & Octet Rule

① Not valid for odd e^- species.
$\boxed{n_1 \neq odd}$ eg NO_2, ClO_2, NO etc.

② Not valid for species having more than 1 Central atom.
eg $S_2O_3^{2-}$, $C_2O_4^{2-}$, CH_3COOH, P_2O_5, N_2O_3 etc.

③ According to Lewis, Species in which centre atom have more than $8e^-$ (Hypervalent) and less $8e^-$ are less stable and dont exist.
less $8e^-$ → Hypovalent.

Hypervalent species :- PCl_5, SF_6, IF_7 etc.



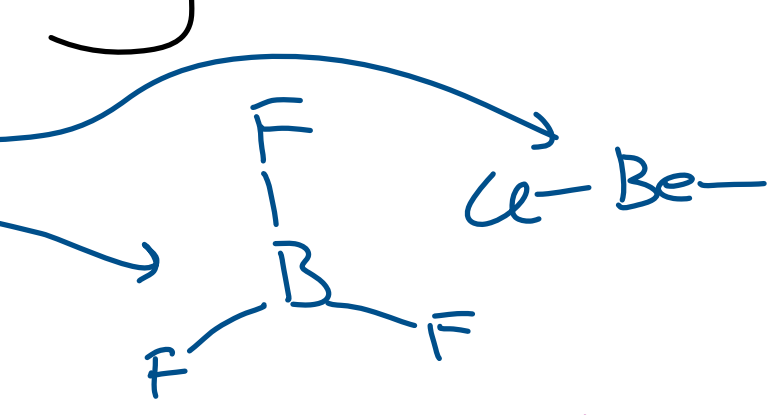
⇓
Expanded octet (ē > 8)

In reality, Atoms having more than 4 orbitals in their valence shell can have Expanded octet.
Such Atoms Belong to Period 3, 4, 5, 6, 7.

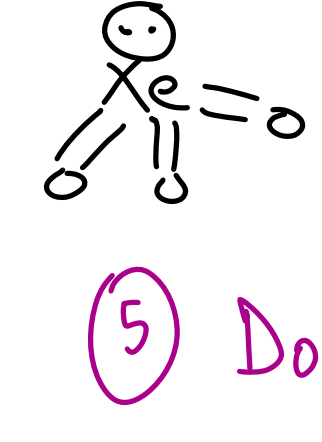
$\boxed{\text{Expanded octet} \rightarrow s \text{ orbital} + p\text{-orbitals} + d\text{-orbitals}}$

eg $Cl = 1s^2 2s^2 2p^6 3s^2 3p^5 3d^0$ → Valence shell
$P = 1s^2 2s^2 2p^6 3s^2 3p^3 3d^0$
Si
Br
I
→ Can use their d-orbitals to Expand octet.

Hypovalent species :- BF_3, $BeCl_2$ etc.



④ If atom achieve noble gas configuration, then it cannot form Covalent Bond.
But in reality Xe (Xenon) form several covalent compounds.



eg XeO_3, XeO_2F_2, $XeOF_4$, XeF_2, XeF_4, XeF_6 etc.

⑤ Does not provide information regarding Shape or structure of species, Bond Energy, Bond length, Bond order, Bond stability, Bond Angle etc.